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Multicriteria Evaluation of Sustainable Agricultural Land Use

A Case Study of Lesvos

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ABSTRACT

Sustainable agriculture has become an important policy orientation in the area of land use. It serves as an analysis framework to reconcile conflicting interests. In the paper the notion of sustainable agriculture will be operationalized by using the concept of environmental utilisation space. This concept offers critical threshold values for various socioeconomic and environmental indicators.

The paper allows for flexibility and variability in expert opinion on sustainable agricuhure by distinguishing various ranges of carrying capacity. Pending on the seriousness of the social costs involved, a 'flag model' is used to analyze the various trade-offs. Next, a multicriteria method using the Regime method is introduced in order to identify compromise solutions.

The (stepwise) sustainability methodology will be applied to the case of agriculture on the island of Lesvos, Greece. The Lesvian agriculture is faced with the threat of erosion and degradation caused by various interlinked developments. Three policy orientations on agriculture on Lesvos are evaluated by means of the flag evaluation method and the Regime method. According to the flag approach, a policy of structural support leads to the most sustainable situation. The scenario of environmental care in agriculture is next the most sustainable, while the scenario of liberalisation of agricultural markets and agricultural trade performs worst. This outcome corresponds to the majority of the outcomes of the Regime evaluation. Thus, the sustainability and continuity of agriculture seems to be best served by public, socio-economic support. Liberalisation of agricultural markets may certainly also be opted for, but would make the future of Lesvos undecisive.

KEY WORDS

sustainability

critical threshold values

scenario analysis

flag approach

Regime method

1 SUSTAINABLE AGRICULTURE

The importance of sustainability as a key concept in environmentally-benign policymaking has rapidly been increasing in the past years. 'Sustainability' is nowadays applied in all kinds of policy fields, while surprisingly the interpretations of this concept are rather diverse. The basic elements of sustainability - or more specifically, 'sustainable development' - can be found in the definition of sustainable development by the World Commission on Environment and Development (WCED): sustainable development is economic development 'that meets the needs of the present without compromising the ability of future generations to meet their own needs (WCED, 1987). In the view of many scientists and policy-makers, this definition implies that policies or projects should explicitly be judged on their environmental impact. In other words, a policy should ***be*** evaluated on the basis of the criterion of ***ecological sustainability, in*** addition to the traditional criteria of ***efficiency*** and ***equity (see,*** for instance, Fresco and Kroonenberg, 1992; Van Pelt, 1993).

Instead of confining the concept of sustainability to 'ecological sustainability', some other authors regard sustainable development as a threefold equilibrium: if development is sustainable, then economic as well as social and environmental interests should be in balance, now and in the future. Sustainability is then characterized by three prominent dimensions: the economic aspect, the social aspect and the environmental aspect. The economic aspect is related to welfare items like income, production, investments, market developments, and price formation. The social aspect concerns distributional and equity considerations, such as income distribution, access to markets, and wealth and poverty positions of certain groups or regions. The environmental dimension refers to quality of life, resource scarcity, and related health variables.

The three aspects of sustainability are strongly interlinked, but also to a large extent mutually conflicting. Economic development, for example, can improve social circumstances, but can also enlarge the gap between rich and poor. De Bruyn and Opschoor (1994) have studied the connection between economic development and the environment, and concluded that the environmental pressure varies for each stage of economic development. Conversely, poverty can have a detrimental influence on the environment: poor societies will make no long-term environmentally desirable investments, since they do not have efficient (agricultural) production methods at their disposal and environmental care is simply not in the direct interest of poor people (Reed, 1992).

The force field of the three dimensions of sustainability can be clarified by means of the Möbius

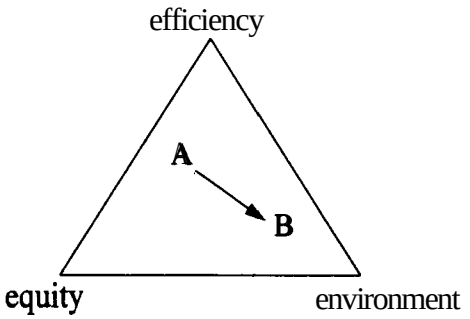

Figure 1 Möbius triangle of three key forces in agricultural evaluation

triangle (see Figure 1). Point A represents the actual state of affairs, while point B may denote a more desirable future state which represents a *sustainable* state of affairs. Reaching this point is a matter of giving and taking in respect of each of the three abovementioned well-being aspects.

In the agricultural sector, the interlinkage of efficiency, equity and environment is an obvious one. The economic performance in agriculture depends, for instance, on the availability and quality of natural resources. Environmental damage may negatively affect agricultural productivity and income, which places pressure on the economic and social structure of rural communities. If however, in the agricultural sector a balance among efficiency, equity and environment is to be found, agricultural policy will have to be guided by the concept of sustainability. The challenge is now to operationalize the concept of sustainability in agriculture. This means that the notion of sustainable agriculture should be converted into operational terms. The next section discusses in more detail the issue of how to make the notion of sustainable agriculture meaningful in a practical context.

2 OPERATIONALIZING SUSTAINABILITY

Ideally, to judge the sustainability of a certain state of affairs or of a certain development, we should be able to 'measure' sustainability. Measuring and judging sustainability requires three building blocks: ***indicators, normative reference values*** (or ***standards),*** and ***an impact assessment methodology. These three*** building blocks will be discussed hereafter. Once we have at our disposal these three building blocks, we may apply these in a stepwise procedure (or sustainability methodology) in order to judge the sustainability of a certain situation. Following such a procedure would also allow the evaluation of an already pursued policy, or of a policy still to be implemented. The sustainability procedure will be discussed in the second part of this section, but we will first address the three building blocks of our analytical framework.

As mentioned above, measuring sustainability is based on three components: indicators, normative reference values, and an impact methodology. *Indicators* are variables that indicate (or approximate) the presence and/or state of phenomena that cannot be directly measured. The state of education in a certain region, for example, can be indicated by the literacy rate, or by the pupil/teacher ratio in primary education. In *this* context, *sustainability indicators* should depict important numerical and observable aspects of sustainability. They should be selected on account of their potential to measure relevant dimensions of sustainable development. The three relevant dimensions are environmental, social and economic characteristics. The identification and definition of sustainability indicators depend on the indicators' relevance regarding the region under consideration and its specific socio-economic and land use conditions. In other words: which indicators should be selected to 'measure' sustainability, depends on the region at hand, and its specific sustainability problem. Another problem concerns the integration of various numerical values reflecting only a part of a certain phenomenon into an aggregate indicator. This requires proper aggregation procedures, based e.g. on non-statistical weightings or on statistical multivariate analyses (see for an overview Coombes and Wong, 1994).

Next, the policy-analytical concept of 'environmental utilisation space' (EUS) is the basis of *normative reference* values. The concept of EUS expresses that at any given point in time there are limits to the amount of environmental pressure that the earth's ecosystems can take without damage to these systems or the life support processes that they enable (Opschoor and Weterings, 1994). Environmental utilisation is what we take (harvest) from the environment and what we return to the environment as waste. Knowing how - and how fast - natural resources regenerate and to what extent the environment can absorb waste, one can assess the extent of use we can make of natural resources (Opschoor and Weterings, 1994). The notion prompts a search for critical levels of environmental pressure beyond which actual environmental systems might become damaged, either reversibly or irreversibly. These critical levels represent the operational boundaries of the EUS, and can be used as the reference levels for environmental indicators.

The application of the EUS concept can be broadened by including matters of sustainability in the wider sense of the sustainability concept. Reference levels can also be assessed for economic as well as social indicators, since critical levels also exist with regard to efficiency and equity. Thus, the boundaries of sustainability are represented by a set of reference values for sustainability indicators. These normative reference values, or *critical threshold values, can be,* for example, safe minimum or maximum levels, 'natural' levels, and - perhaps the most popular though debatable point of reference - present levels (Van Pelt, 1993). They may be assessed on the basis of scientific research and/or expert opinion.

Finally, before any evaluation or comparative analysis of projected indicator values can be made, the projections themselves - in the form of impact assessments - should be made, by means of *an impact methodology*. Impact assessment methods are either ad *hoc* or *structured* (Blaas and Nijkamp, 1992). Ad hoc impact assessment is a way to analyse measurement problems for which no formal operational model can be developed because of time constraints, non-repetitive situations, or lack of data. An example of ad hoc analysis is an informal analysis using expert views. Ad hoc methods are fairly fast: in a short time span relevant insights into the

expected consequences of any event can be generated, on the condition that sufficient expertise and experience is available to enable realistic estimates of expected impacts. Ad hoc impact analyses however, do not offer the same degree of precision, controllability and transferability as structured impact analyses do. The main characteristic of structured impact analysis is that it is systematic: the effects of (a set of) policy measures on relevant policy variables are *systematically* traced under varying conditions. This means that projections are made on the base of formal - usually quantitative (econometric or statistical) - techniques and models.

It is now clear that indicators, normative reference values and an impact methodology are essential ingredients for a meaningful sustainability methodology, conceived of as a procedure for assessing the sustainability of a given situation. This procedure consists of four steps. First, the sustainability problem has to be identified. Second, various policy scenarios (or strategies) for the future should be designed and formulated. Third, each policy scenario (or strategy) should be evaluated, and finally, a comparison of the various performances of policy options should be made. These steps will now successively be discussed.

First, the *identification of the sustainability problem* is the stage in which the nature of the sustainability problem is assessed. A certain agricultural sector in a given region can, for instance, be confronted with a poor or threatened environmental quality, with social stress, or with substandard economic performance. It should be noted that the problem exists for *a* given *agricultural sector in a given region:* both the sector and region should be demarcated. The agricultural sector can be distinguished according to main activities (crops, e.g.), and the region can be delimited by the size, the openness, and the like.

The use of *scenario analysis* (or *strategic choice analysis)* enables a systematic way of scanning various uncertain future choice possibilities. A scenario is a possible image of future events, like a policy strategy to pursue. Each scenario can be characterized by a certain set of values of sustainability indicators, assessed by means of an impact assessment method. In that way, each scenario can be judged on the basis of its sustainability, while its performance regarding sustainability should be considered in making possible policy decisions. This judgement however, requires an analysis of the projected indicator values. This analysis is next carried out in *the* third step, *policy evaluation.*

To evaluate policy scenarios with regard to sustainability, the indicator values characterizing each scenario will have to be compared with the already discussed set of normative reference values. These reference values, or *critical threshold values* (CTVs), indicate the limits of sustainability; they cannot be exceeded without causing unacceptably high damage and risk to the environment. The entire set of CTVs acts as a reference system for judging actual states or future outcomes of scenario experiments, in particular policy strategies.

The fact is that this reference system is not always unambiguous: CTVs differ per region and they depend on local socioeconomic and natural conditions, while different experts and decision-makers may have different views on the precise level of a CTV. So there is scope for uncertainty analysis on both measurement precision and expert knowledge. To avoid a high degree of ambiguity, a band width for the CTV in question can be introduced by assessing a

CTV_{min} and a CTV_{max} around this median CTV. Assuming that the indicators are assessed as cost or damage variables, CTV_{min} indicates a conservative estimate of the maximum allowable threshold of the sustainability indicator concerned. CTV, refers to the maximum allowable value of the sustainability indicator beyond which an alarming development will certainly start. To visualize the degree of sustainability of formulated future scenarios, the set of indicator values characterizing each actual scenario can be compared with the prespecified CTVs. This comparison results in a certain coloured 'flag' for each indicator: a *green flag,* if the indicator value is below the most conservative CTV; an *orange flag,* if the indicator value is below the median CTV, but exceeds the CTV_{min}; a *red flag,* if the indicator value exceeds the median CTV, but is still below the CTV,; and a *black* flag, if the indicator value gives cause for substantial concern since it exceeds the CTV,,. This flag evaluation is clarified in Figure 2.

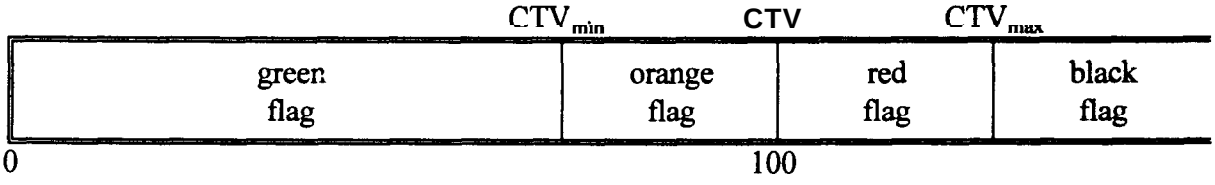

Figure 2 Flag representation of levels of concern on indicator ***values***

Once more, it is assumed, that the sustainability indicator is a so-called cost indicator (i.e., 'the lower, the better'), and that the minimum value of the indicator is 0, whilst the median CTV is standardized at a value of 100. The colour of the flag should be interpreted as follows:

0 green flag: no reason for specific concern
0 orange flag: be very alert
0 red flag: reverse trends
0 black flag: stop further growth or operation.

A further examination of the flag colours pertaining to the total set of indicators (or evaluation criteria) may offer practical insight into the degree of sustainability of the scenario in question.

The next step is *the policy assessment,* i.e., which scenario or policy strategy is more desirable in light of the diverse characteristic judgement criteria. Here it it useful to resort to multicriteria analyis. Given the uncertain degree of precision of the indicators (including even qualitative information), we will use here the Regime method. The Regime method, a multicriteria evaluation method which does not necessarily need a cardinal assessment of CTVs, can be used as a complement to the flag approach. The Regime method is a qualitative multiple criteria evaluation method, aiming at providing a rational basis for solving discrete choice problems characterized by multiple evaluation criteria which are intangible and incommensurable (Hinloopen et al., 1982). The Regime method is, like other multiple criteria analysis methods, based on two kinds of input *data, viz. an impact matrix* and a set of *political weights* attached to the criterion effects. The impact matrix represents the expected values of indicators (linked to policy criteria) for each of the choice options or strategies. The weights indicate the importance of the criterion in question in comparison to the other criteria. The result of the Regime method is a *ranking* of scenarios, expressing which scenario is preferable.

The last step in the sustainability methodology, viz. the *final assessment,* concerns an overall evaluation of the choice options. The performance of the various policy options are compared, and the degree of sustainability of the fmal option, either relatively or absolutely, can be assessed and communicated to policy-makers.

This stepwise sustainability methodology has been applied in practice, viz. to the case of sustainable agriculture on the island of Lesvos, Greece. This application and its results are described in the following sections.

3 THE CASE OF AGRICULTURE ON LESVOS

The issue of sustainable agricultural policy on the island of Lesvos will now be used to illustrate the operational framework for the concept of sustainable agriculture. In our application, the four steps described above are all passed through.

3.1 Identification of the sustainability problem

The very first step in operationalizing sustainability is to identify the problem regarding sustainability in the region under study. The area concerned is the island of Lesvos, one of the North-Eastern Aegean Islands in Greece, near to the Turkish coast. It comprises 1630 square kilometres.

The main agricultural activity on the island is the cultivation of olives. The about eleven million olive trees on the island render the island one of the most important exporters of Greek olive oil. The other important branch of agricultural activity is the breeding of goats and sheep. The primary sector accounts for about 25% of total gross regional product, which means that the primary sector is a sector of substantial importance. Employment on Lesvos is characterized by multi-activity: farmers do not merely live from farming. On Lesvos, farms are relatively small.

Since Lesvos is mainly a mountainous area and lacks sufficient water supply, the Lesvian agriculture is characterized by terrace-cultivation. The mountainous conditions form an impediment to the use of advanced agricultural implements. Another cause for the traditional way of farming on Lesvos is the conventional attitude of Lesvian farmers. This attitude can partly be explained by the fact that the island population has been ageing in the last few decades. Young people left the rural areas and migrated to the urban areas, especially to the mainland of Greece, where fast economic growth was stimulated by the Greek government in the fifties (Loumou et al., 1995; Baaijens, 1996).

Centralization of governmental authorities in Athens, the breaking-up of the political and economic relationships with Asia Minor after the liberation from the Turks, and the fact that infrastructural facilities lagged behind the infrastructure in the mainland, also played a role in the out-migration from the island of Lesvos in this century. Another factor stimulating out-migration is the rising importance of competitive substitute products of olives and olive oil

(Margaris, 1992; Loumou et al., 1995). The proliferation of such products resulted in the economic decline of Lesvos, followed by an emigration of its inhabitants to destinations in continental Greece and abroad. Both the out-migration and the urbanisation in the mainland of Greece led to a decline in the rural population, threatening the continuity of the agricultural sector. The abandonment and lack of maintenance of the olive groves is the most important symptom of the declining importance of agriculture on the island of Lesvos.

The abandonment and neglect of agricultural areas, and of olive groves more specifically, is the cause of the main environmental problem in the Lesvian agriculture, viz. the threat of erosion and desertification. The abandonment of olive groves and of plantations of other perennials has led to a neglect of the terraces. This takes away the protection against erosion. In addition, with the abandonment of terrace cultivation, animal husbandry became more important on the island of Lesvos. The availability of feed for the animals can be increased by setting fires to the vegetation of certain areas. During the first year after such a fire, a lot of herbaceous plants appear, as a result of the activated germination of seeds that lie in the soil seed bank. The increase in feed availability however, is a short term increase, if intense grazing follows. If such intense grazing follows, herbaceous plants are either eaten or trampled by grazing animals, and the ecosystem has no time to regenerate. The only plants which are able to survive are those which are resistant to grazing. Since most of these plants are unpalatable, shepherds wish to get rid of them, and may set fires more frequently, resulting in continuous degradation.

To combat erosion, new trees should be planted. The current market situation gives no incentive to re-planting. In addition, new planting is neither stimulated by any governmental or European Community (EC) subsidy. *The* policy of *the* EC *aims* at *maintaining* current plantations, not at *increasing* the area and production of perennials.

The question is, whether alternative feasible policies will change this environmental problem, and whether they will have an influence on economic and social circumstances in agriculture on Lesvos. The effects a set of different policies may have on sustainability, will be discussed and evaluated hereafter.

3.2 Evaluation of future options

The range of possible policies-which affect agriculture on Lesvos is sizable. In the context of our paper, it is more useful and efficient to regard only a few contrasting policy directions, to get a clear idea of differences and similarities among alternative futures. First, a continuation of agriculture on Lesvos could be opted for. This means that an important role is given to agriculture in the future of Lesvos, like it has always been. This scenario is called the 4S (FORCE) scenario, and will be worked out hereafter. The second strategy for policy on Lesvos is towards environmental priority. This means an explicit support for a preservation or improvement of the environmental circumstances on the island. This scenario is called the GREEN scenario. Third, one might choose not to intervene in the development of Lesvos, and to rely on the working of the market: the so-called 'invisible hand' will stabilize the markets and bring the economy into equilibrium. In this case, the future of Lesvos will be determined by

economic forces. This scenario is the MARKET scenario. These three policy orientations will now be discussed in more detail.

The 4S-scenario - Structural Support for Socio-economic Similarity - is a scenario of Structural policy, and is based on an EC-regulation, viz. Council Regulation 20 19/93 (see Council of the EC, 1993). This regulation is meant to support the smaller Aegean Islands in coping with their specific socio-economic problems caused by their natural handicaps. Among these natural handicaps, the EC recognizes the smallness of the islands, thwarting an integrated development or realization of advantages of scale; the small, ageing population which is tending to decline; the geographic position far from the production centers of the mainland of Greece, making exploitation of the small amount of raw materials on the islands hardly viable; inconvenient natural circumstances, like dry climate and infertile and mountainous soil; and a very vulnerable natural environment. The EC also recognizes, that the islands are scattered, which hinders commercial traffic and causes high transportation costs. All these natural handicaps are to a large extent reflected on the island of Lesvos, and they cause arrears regarding agricultural income with respect to other regions in the European Community. They also cause differences in agricultural structure compared to other Community regions, which is demonstrated by different amounts of land available to a farmer, different contributions of agriculture to gross domestic product, and different degrees of labour productivity (Slot, 1988). This scenario of structural policy aims at alleviating those regional differences in income and socio-economic situation. This means that the production of several arable crops and fruit is supported, that various traditional agricultural activities are promoted, and that a certain degree of control and management of movements in the markets, in policymaking and in policy implementation is strived for. Summarizing, 4S is a scenario that aims to maintain, restore, or improve agricultural activities on Lesvos, so that the socio-economic arrears will be overtaken.

The GREEN scenario - Gains to Ruralization and Environment ENlinked - is a scenario of environmental care in agriculture. The starting-point of this scenario is the idea that a farmer has a dual role as a producer of food and a guardian of the countryside; managing the soil and the countryside is a prerequisite for the viability of agricultural production in the long term. Too much emphasis on production however, can lead to over-intensification and thus to over-exploitation and degradation of the natural resources on which agriculture itself depends. The basis of the GREEN scenario is an EC-regulation also relevant for agriculture on Lesvos, viz. Council Regulation 2078/92 (see Council of the EC, 1992). This regulation exemplifies the integration of environmental and agricultural policy, and stresses the dual role of farmers. Therefore, the use of farming practices which reduce the polluting effects of agriculture, is promoted; an environmentally favourable extensification of agricultural practices is furthered; the upkeep of abandoned farmland and woodlands is promoted; long-term set-aside of agricultural land is promoted; land management for public access is furthered; education and training for farmers is supported; and ways of using agricultural land which are compatible with protection and improvement of the environment, the countryside, the landscape, natural resources, the soil and genetic diversity are advanced.

The third scenario is the *MARKET scenario: Minimizing Agroproduction Relief and Knocking down Established Tar@.* This scenario is a scenario of liberalisation of agricultural markets

and agricultural trade. The ideas of this scenario are in conformity with the sectoral Agreement on Agriculture, a sector-specific agreement in the framework of the General Agreement on Tariffs and Trade (GATT). In the Agreement on Agriculture, concluded during the Uruguay Round, it was arranged that a gradual liberalisation of agriculture should be initiated, after agriculture had come to be effectively excluded from the reach of GATT disciplines in the course of time. Roughly, the Agreement on Agriculture deals with three issues: market access, domestic support, and export competition (Commission of the EC, 1994; Hoekman, 1995; Trebilcock and Howse, 1995). Regarding *market access* it was agreed that existing nontariff barriers (NTBs) be converted into tariffs, and new measures of this kind are to be prohibited. The reason for this is that NTBs interfere with efficiency and produce inequities, and that tariffs are more transparent than NTBs (Kenen, 1994). It was also agreed that all agricultural tariffs be bound, which means that the rates cannot be raised, unless specific conditions that are set out in other parts of the GATT are satisfied. In addition, average tariffs should be reduced, and minimum market opening criteria are to be established through minimum import levels. Secondly, *domestic production support* to agriculture is to decline, and finally, *export subsidies* are to be reduced. The export subsidy levels are bound, and the use of new export subsidies is prohibited.

As a consequence of the provisions agreed upon in the Agreement on Agriculture, two courses of actions and events are conceivable for the case of Lesvos island. Firstly, it is thinkable that the small scale of agriculture will disappear, and that the Lesvian agriculture will be dominated by a few large landowners. This would mean that financial sources per farm would be larger, which could offer the possibility to use more advanced farming methods, thus increasing production efficiency. This scenario is called 'MARKET I: Scaling Up'. The second possibility one could think of, is that small landowners will co-operate by using common agricultural equipment, by purchasing together, by putting their products on the market commonly, etc.. This could give the opportunity to make use of more advanced farming methods, and to lower some overhead. In this version, which is called 'MARKET II: Co-operation', every farmer's feeling of responsibility for his own land and livestock will remain, since his income will directly depend on these resources.

Expectations regarding the sustainability effects of each aforementioned scenario for Lesvos were expressed by several local experts. Here, the impact methodology used is obviously an ad hoc impact assessment method, using expert views. The experts were asked to express, what, according to them, the influence of each scenario would be on each of the twenty evaluation criteria or indicators distinguished. In this way, the range of qualitative foreseeable effects of each scenario can be assessed in a systematic way. The expectations are summarized in Table 1.

	4S	GREEN	MARKET I	MARKET II
ECONOMIC				
general & structural				
1. GDP of the primary sector as a percentage of total GDP	+	+/-	-	
2. average income out of farming activities as a percentage of annual household expenditure	+	+/-	+/-	
3. number of farms	+	+/-		
4. farm size	+/-	+/-	+	
livestock numbers				
5. number of goats	+/-			
6. number of sheep	+/-			
7. number of cattle	+			
production figures				
8. production of olives	+	+	+/-	
9. production of meat	+			
10. production of milk	+		-	
land use				
11. total agricultural area in use	+/-			
12. total area in field and pasture	+/-		-	
13. surface area planted with olive trees	+/-	+/-		
SOCIAL				
14. total population	+/-	+/-		
15. economically active primary sector	+	+/-		
16. employment in the primary sector as a percentage of total employment	+	ii-	-	
ENVIRONMENTAL				
17. number of olive trees	+/-	+/-		-
18. olive yield per hectare	+/-		+	+/-
19. area of abandoned olive groves as a percentage of total area of olive groves			++	+
20. number of sheep and goats per hectare of pasture land	+/-			

++ = substantial increase
+ = slight increase
+/- = neither increase, nor decrease
- = slight decrease
-- = substantial decrease

Table 1 Impact matrix of three scenarios

The effects of the 4S-scenario were expected to be most positive, while the MARKET scenarios appeared to perform worst, and GREEN had an intermediate position. However, on the base of the plain data obtained from mainly interviews, the sustainability impacts of each scenario cannot be accurately assessed. For a precise analysis of the scenarios one needs evaluation methods, enabling a profound-interpretation of the data.

The first evaluation method applied to the case of agriculture on Lesvos, is the flag evaluation method, as described before. Clearly, this approach requires establishing a set of CTVs. Acknowledging that CTV-levels may vary per region, local expertise should be consulted in establishing CTVs. The opinion of local experts on CTVs is represented in Table 2.

	lowest CTV	highest CTV
ECONOMIC		
general & structural		
1. GDP of the primary sector as a percentage of total GDP*		25%
2. average income out of farming activities as a percentage of annual household expenditures*		20%
3. number of farms		20,000
4. farm size		1 Ha
livestock numbers		
5. number of goats*		40,000
6. number of sheep*		200,000
7. number of cattle*		9,000
production figures		
8. production of olives		90,000 t./yr
9. production of meat		4,300 t./yr
10. production of milk		30,000 t./yr
land use		
11. total agricultural area in use		60,000 ha
12. total area in field and pasture		60,000 ha
13. surface area planted with olive trees*		46,500 ha
SOCIAL		
14. total population		90,000
15. economically active primary sector*	8,000	9,000
16. employment in the primary sector as a percentage of total employment*		30%
ENVIRONMENTAL		
17. number of olive trees		11 ,000,000
18. olive yield per ha*	1,500 kg/ha	2,000 kg/ha
19. area of abandoned olive groves as a percentage of total area of olive groves		20%
20. number of sheep and goats per ha of pasture land		1.4 head/ha

* refers to the *department* of Lesvos

Table 2 CTVs regarding Lesvian agriculture

For most indicators *present values* are defined as critical threshold values. The idea behind this is, that although the environment of the island is indeed under pressure, the current state of the environment is still acceptable.

Combining the CTVs and the projections for each of the three scenarios enables the application of the flag approach. In light of the scarcely available qualitative expert information, for none of the indicators four flags could be defined; the information available on CTVs enables either a two-flag representation (red and green), or a three-flag representation (red, orange, and green). Since 4S shows most green, the 4S-scenario appears to lead to the most sustainable situation. It also shows a lot of mixed green/red colours, indicating that many indicators fluctuate around the borders of sustainability. The 4S-scenario performs very well with regard to the economic and social dimensions of sustainability, but its performance with regard to the environmental aspect is ambiguous. Its performance regarding abandonment of olive groves is, for example, sustainable, but the olive yield and the number of sheep and goats per hectare of pasture land are of an unsustainable nature.

The least sustainable strategies are both versions of the MARKET scenario. Just for some general economic and structural indicators more or less sustainable scores can be identified.

The GREEN scenario appears to perform on an intermediate level. The economic performance is for the most part unsustainable, and with regard to the social dimension GREEN is balancing on the edge of sustainability. Remarkable is the outcome of the GREEN scenario with regard to the environment: the flags do not show a better performance in this field than the other scenarios do, although one would expect the GREEN scenario to perform better in this field.

As a complement to the flag evaluation, the computerized Regime method is used to evaluate the scenarios. As said before, the Regime method is based on two kinds of input data, viz. an impact matrix and a set of political weights attached to the criterion effects. By considering all indicators - twenty, in the case of Lesvos - more than 160 million different weight sets are, in principle, possible. Let us look at one of those possibilities in more detail.

The selection of weights is obviously a political matter: the importance attached to each criterion, class of criteria or aspect of sustainability depends on political choices. These political choices are inter alia based on certain assumptions regarding the present state of affairs. One can assume, for example, that a wealthy society can afford more attention to the environment than a poor society can do. This would mean that stimulating economic growth would result in an improvement of environmental circumstances. Economic stimulation would then be important, whereas environmental policy as such would be of little importance: environmental improvement will follow on economic growth as a matter of course. The weight set with regard to the three aspects of sustainability would then be:

$$\text{weight}_{\text{economic}} > \text{weight}_{\text{social}} > \text{weight}_{\text{environmental}}.$$

The economic aspect of sustainability comprises four sub-aspects: *general and structural characteristics, livestock numbers, production figures,* and *land use. The importance* of these sub-aspects should be weighed against each other as well. One might, for example, be of the opinion, that *the general and structural* indicators give the best picture of the economic state

of a sector in a region. Consequently, the category of *structural and general* indicators would get the highest weight. Income, which is an essential variable in *the structural and general* category, is generated by producing. *Production figures* would then be the second most important indicators of the economic state. The capital of a farmer consists of - among other things - land and livestock. Since olives are a more important agricultural product than meat or dairy products on the island of Lesvos, *land use* will then be the third important category, and *livestock* the fourth. The weight set regarding the economic sub-aspects will then be as follows:

$$\text{weight}_{general\ \&\ structural} > \text{weight}_{production\ figures} > \text{weight}_{land\ use} > \text{weight}_{livestock}.$$

Finally, weights should be attached to each individual indicator. Assuming that the economic indicators are quite homogeneous within each category, the weight sets for the economic indicators are as follows (the numbers correspond to the numbers as mentioned in Tables 1 and 2):

weight, = weight, = weight, = weight,,
weight, = weight, = weight,,
$\text{weight}_8 = \text{weight}_9$ = weight,,,,
weight, $_1$ = weight_{12} = weight,,.

With regard to the social aspect, a rational argumentation might be as follows: the 'survival of the island does not just depend on agriculture. Agriculture is indeed an important sector, but the equilibrium on the island requires that people work in other sectors as well. The most important social indicator thus is the *total* population. No population, or too little people on the island, would mean no future for the island. To give an indication of the significance of agriculture on the island, the employment in the primary sector *as a percentage of total employment* is a better indicator *than the absolute number* of economically active in the primary sector. As a result, the weight set regarding the social aspect would be:

$$\text{weight,,} > \text{weight}_{16} > \text{weight}_{15}.$$

The environmental aspect, in conclusion, can best be measured by the number of sheep and goats per hectare of pasture land, since one may argue that overgrazing is the most important cause of the major environmental decay in Lesvian agriculture. The number of sheep and goats per hectare of pasture land needs to be assessed. The area of abandoned olive groves as a percentage of the total area of olive groves gives a better indication of the most important environmental problem on the island than olive yield per hectare does. Olive yield per hectare is influenced by many other factors than the environmental state of an area, like climate and way of harvesting. The least important environmental indicator is the number of olive trees. The plantation of trees prevents indeed the soil from eroding, but *the* mere *number of olive trees* gives no indication of the quality of the plantation and the soil, so it is no good identifier. The resulting weight set is:

$$\text{weight,,} > \text{weight}_{19} > \text{weight}_{18} > \text{weight}_{17}.$$

Summarizing, the weight set is as follows (in order of decreasing weight):

1. GDP of the primary sector as a percentage of total GDP
   average income out of farming activities as a percentage of household expenditure
   number of farms
   farm size
2. production of olives
   production of meat
   production of milk
3. total agricultural area in use
   total area in field and pasture
   surface area planted with olive trees
4. number of goats
   number of sheep
   number of cattle
5. total population
6. employment in the primary sector as a percentage of total employment
7. economically active primary sector
8. number of sheep and goats per hectare of pasture land
9. area of abandoned olive groves as a percentage of total area of olive groves
10. olive yield per hectare
11. number of olive trees.

Applying the Regime method to this weight set results in the ranking:

1. 4S
2. GREEN
3. MARKET1
4. MARKET II.

We see, that in this case the 4S scenario is regarded the most sustainable scenario. This means that socio-economic support should be preferred to a policy of environmental care, and to a policy of liberalisation. Liberalisation might increase net economic welfare in a certain region, but as a result of welfare redistribution, the Lesvian agriculture is worse off if agricultural markets are liberalized. Therefore, sustainability is not ensured in case of the MARKET scenario.

Clearly, this outcome is just one of the many possible outcomes. In 99.8 percent of all weight sets, however, 4S appears to rank first, and in 99.7 percent of all weight sets, both MARKET scenarios are the scenarios performing worst, just like in the case described above.

If we look at the results in more detail, the Regime method designates the 4S-scenario as most sustainable for all weight sets, if just the economic aspect is considered. The GREEN scenario is the second most sustainable in that field, and the MARKET scenarios are the least sustainable.

The same holds for the *social* aspect: all weight sets make GREEN rank second, before the MARKET scenarios, and after the 4S scenario. The outcome of the Regime method regarding the *environmental* aspect however, is not so unambiguous. More than 40 percent of the weight sets leads to a number one ranking of 4S, while about 30 percent of the weight sets regarding the environmental indicators results in a number one ranking for the GREEN scenario. Another 30 percent of the weight sets designates the MARKET I scenario as environmentally most sustainable, while the chance that MARKET II is ever ranked first, is almost nil. One cannot say however, that 4S is conclusively performing most sustainably regarding the environmental state of affairs, followed by GREEN, MARKET I, and, finally, MARKET II. Although the main share of the weights leads indeed to a number one ranking of the 4S scenario, it is not certain whether all of these weight sets are equally plausible (for a complete overview of the possible weight sets and the accompanying scenario rankings, see Hermanides, 1996).

If we compare the results of the flag evaluation with those of the Regime evaluation, one may conclude that the final outcome of the flag evaluation corresponds to the majority of the outcomes of the Regime evaluation. The outcomes of both evaluation methods per aspect of sustainability are largely similar as well, although a scenario ranking regarding the environmental aspect is somewhat complex. The fact that the Regime method allows for policy priorities expressed by weights, makes the Regime method clearly more subtle than the flag method.

4 FINAL ASSESSMENT

The findings of our research are not just of theoretical value, but also of use in practice, since we can learn from them in several ways. First, of course, the evaluation of policies suggests a direction in which a sustainable policy regarding the Lesvian agriculture should be developed. It appears from the policy evaluation, that the sustainability, and consequently the continuity of agriculture on Lesvos, is best served by public, socio-economic support. If the Lesvian agriculture is left to fend for itself, it is doomed to unsustainability, and in the long run agriculture might disappear from the island. Nevertheless, one may still choose to liberalize agricultural markets, since it might yield a net economic benefit. In this case, the future of Lesvos would be more undecisive. The question is then what economic activity will replace agricultural activity. Lesvos' natural handicaps may not just form obstacles for the agricultural sector, but they might also cause disadvantages to other sectors. Finally, dramatic out-migration might result in the worst case.

The second lesson to be learnt from the findings of the research, concerns the shortcomings encountered in the research methodology, and the flaws in the application of the methodology. The most obvious problem was faced in inquiring the experts regarding their estimates for the future. They were asked to express how indicators would change with respect to the present state of affairs. To use these estimates in the flag model however, one should not ask how *things* would change in respect of *the present indicator values,* but in

respect of the *critical threshold values*. This problem obfuscated fifteen percent of the picture resulting from the flag approach.

In addition, a fairer, more balanced view on the future would have been obtained if more experts from divergent disciplines would have been consulted. The experts consulted in our case had more or less the same background: they were mainly ecologists and agricultural engineers. This may have resulted in a coloured picture of the future expectations.

Finally, some further research on feedback effects may be useful, in order to refine the sustainability methodology. Each of the four steps of the sustainability methodology follows after the previous one in a logical, almost natural order. However, the result of each step might influence one or more of the previous steps, as a kind of feedback. For example, the results of the policy evaluation can definitely change one's view on the sustainability problem, which is identified in the first step of the methodology. If the evaluation has given insight into the impact of a certain policy on sustainability and if the policy is about to be pursued, then this may change the sustainability problem. As a result, other indicators will have to be selected in successive steps, and the expected indicator values may then be different. This makes the methodology a repeating process, in which each and every step can be adjusted and readjusted.

A second feedback-loop may be distinguished: the recommendation concerning the future of Lesvos, resulting from the policy evaluation, should be re-considered if new policy plans are envisaged and formulated. Then, the new policy plans should pass through the entire procedure of the methodology, and so a real 'loop' with a feedback structure would have to be created. There is indeed quite some scope for further experimental research in the field of sustainable agriculture.

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The flag approach applied to the case of Lesvos

ECONOMIC INDICATORS

general and *structural*
1. GDP of the primary sector as a percentage of total GDP
2. average income out of farming activities as a percentage of annual household expenditures
3. number of farms
4. farm size

livestock numbers
5. number of goats
6. number of sheep
7. number of cattle

production figures
8. production of olives
9. production of meat
10. production of milk

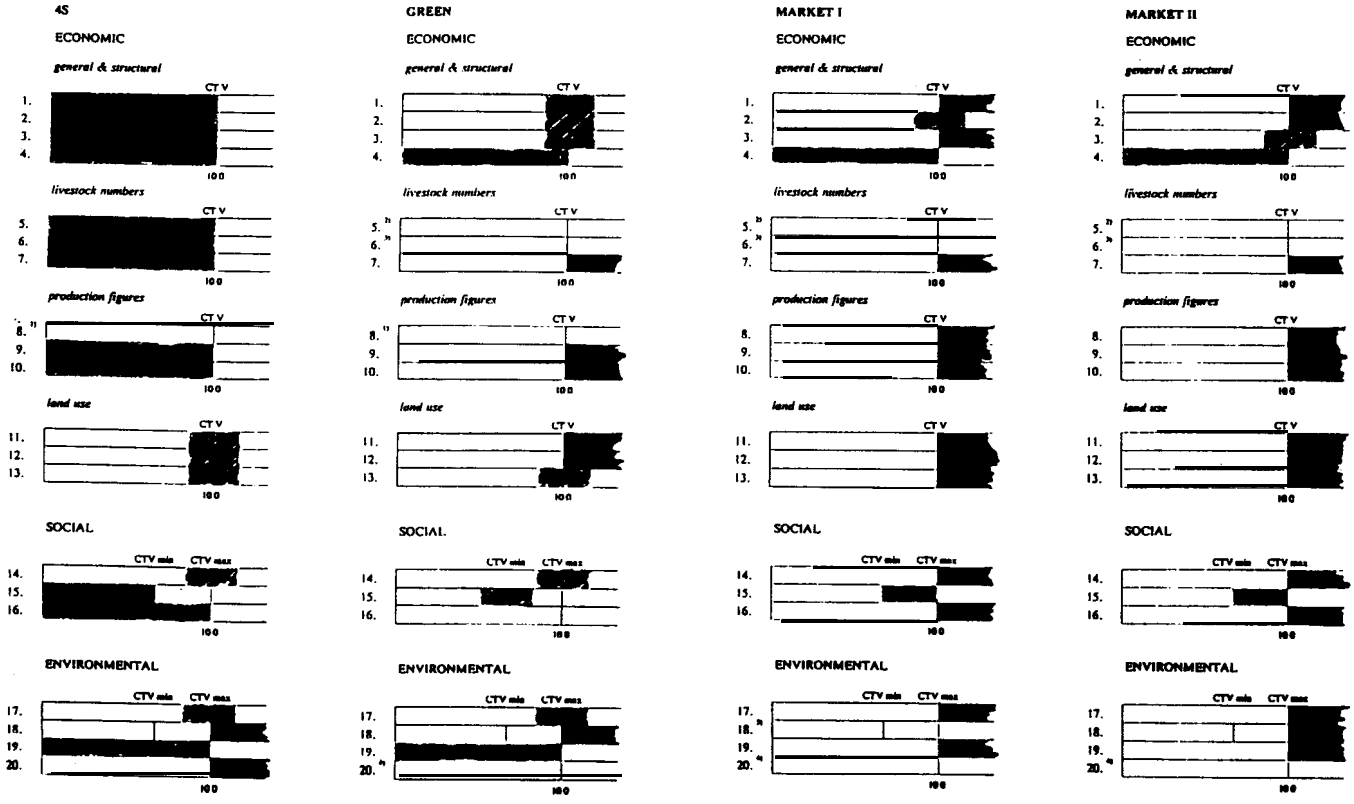
land use
11. total agricultural area in use
12. total area in field and pasture
13. surface area planted with olive trees

SOCIAL INDICATORS

14. total population
15. economically active primary sector
16. employment in the primary sector as a percentage of total employment

ENVIRONMENTAL INDICATORS

17. number of olive trees
18. olive yield per ha
19. area of abandoned olive groves as a percentage of total area of olive groves
20. number of sheep and goats per ha of pasture land



1) *The CTV* of *production* of *olives* is 90,000 tons a year. The actual production at the moment is of a much lower level. The 4S scenario will cause an increase in production, but it is not sure, whether this increased production will be lower or higher than 90.000 tons a year.

2) The CTV of *number* of *goats* is 40,000 heads. The actual number of goats is about 70.000. It is not clear, whether a decrease in the number of goats will lead to an unsustainable number of goats, or whether it will remain a number above 40.000.

3) The CTV of number of *sheep* is 200,000. The actual number of sheep is almost the double. A decrease in the number of sheep would lead to a worse economic situation, but it is not clear, whether the number of sheep will be lower than 200.000.

4) The CTV of number of *sheep and goats per hectare of pasture land* is 1.4 head/ha. At the moment, this number of sheep and goats per hectare of pasture land exceeds the CTV. A decline of this number will be a change for the better, but it is not sure whether this will lead to a sustainable situation indeed.

5) The CTV, of olive *yield per hectare* is 1.500 kg/ha. The actual olive yield is much less. It is not clear whether a yield higher than the actual level will exceed 1,500 kg/ha, or even 2,000 kg/ha.